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Forest Pest Management Report

3430

BIOLOGICAL EVALUATION R10-87-2

SPRUCE BEETLE

3430

Biological

Evaluation R10-87 - 2

SPRUCE BEETLE

CHUGACH NATIONAL FOREST

and

ADJACENT LANDS

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INTRODUCTION

The spruce bark beetle, (Dendroctonus rufipennis (Kirby)) (App. A) is one of the most damaging forest pests throughout Alaska's spruce forests. Bark beetle activity has been most severe in south-central Alaska white (Picea glauca (Moench) Voss). and Lutz spruce (P. glauca x lutzii Little) stands. Infestations have been building on the Chugach National Forest portion of the Kenai Peninsula since the early 1970's. By 1979 infestations covered approximately 31,200 acres, but approximately 42,000 acres of spruce forest were infested by 1986. Infestations are now declining because most susceptible (large diameter, slowly growing) trees have been killed.

Forest Pest Management personnel performed a number of biological evaluations in areas of beetle activity on the Kenai Peninsula; many of which are on National Forest Land (Holsten and Zogas 1979, Holsten 1981a,b). Objectives of those evaluations were to provide management with updated information concerning spruce beetle population trends and volume losses, as well as an array of management alternatives.

OBJECTIVES

Five to six years have passed since these biological evaluations were first done, so we decided to re-evaluate as many of the original areas as possible to determine:

(1) If original forecasts pertaining to spruce beetle population trends were accurate,

(2) How much commercial spruce has been killed during an infestation, and

(3) How much, if any, of the unattacked residual spruce have increased in growth rate as a result of a decrease in competition due to spruce beetle caused mortality of the overstory.

PRELIMINARY EVALUATIONS

Ten areas were evaluated during the summer of 1986 by FPM personnel (Fig. 1A,B). These areas are described below. Effort was taken to locate, as closely as possible, the exact transects of five years ago.

Study Sites: The Silvertip Creek area is located on the Kenai Peninsula and was originally evaluated in 1980 (Holsten 1981). The stand, in 1980, was composed of 95 percent spruce. Average radial growth for the last inch of growth of dominants was 0.5mm/year. Beetles had been active in the stand for two to three years. Spruce volume averaged 7,452 b.f./acre with 10% of the commercial spruce already killed by the bark beetle (Table 1A). The infestation was increasing based on Knight's (1960) sequential sampling plan for spruce beetles.

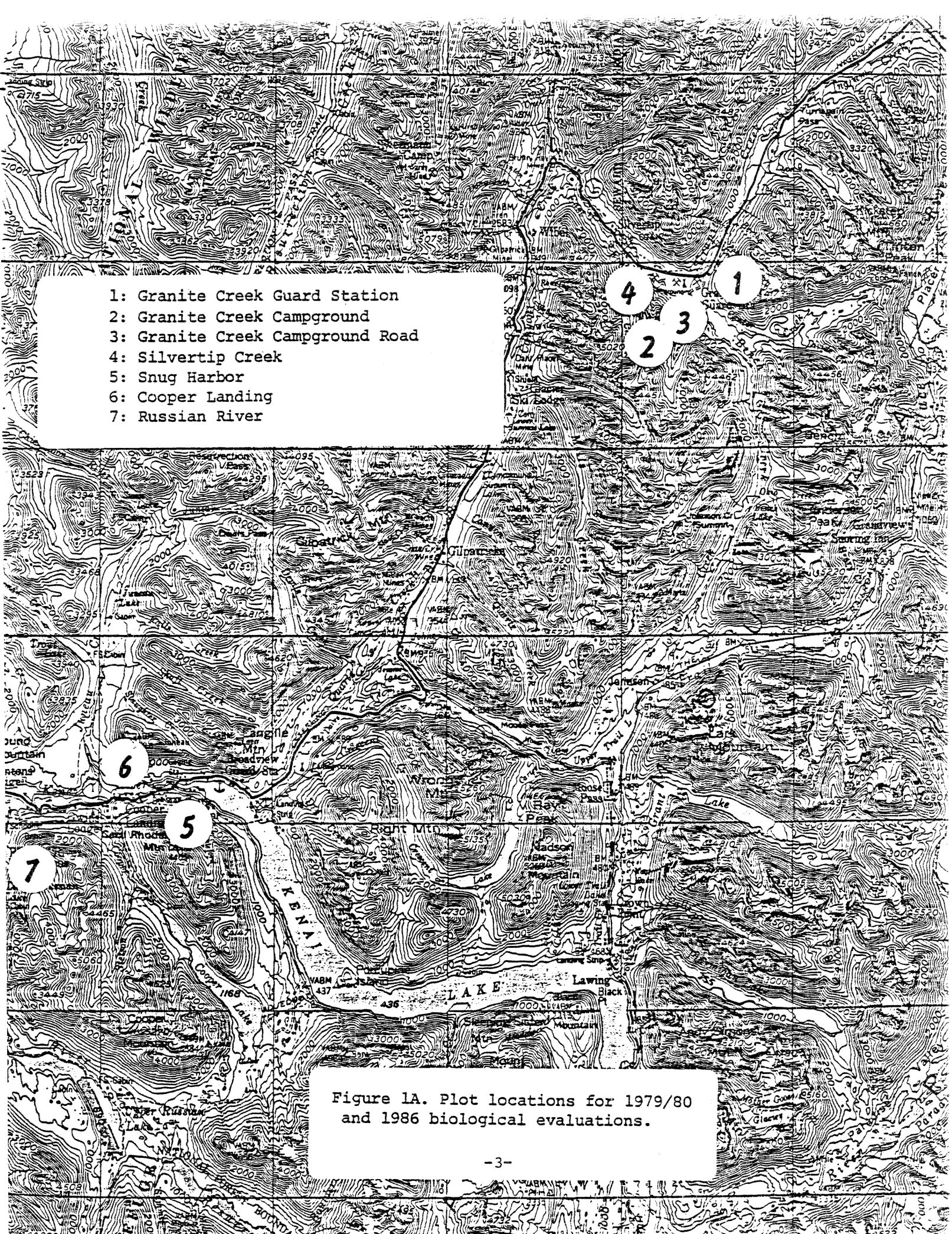

Figure 1A. Plot locations for 1979/80 and 1986 biological evaluations.

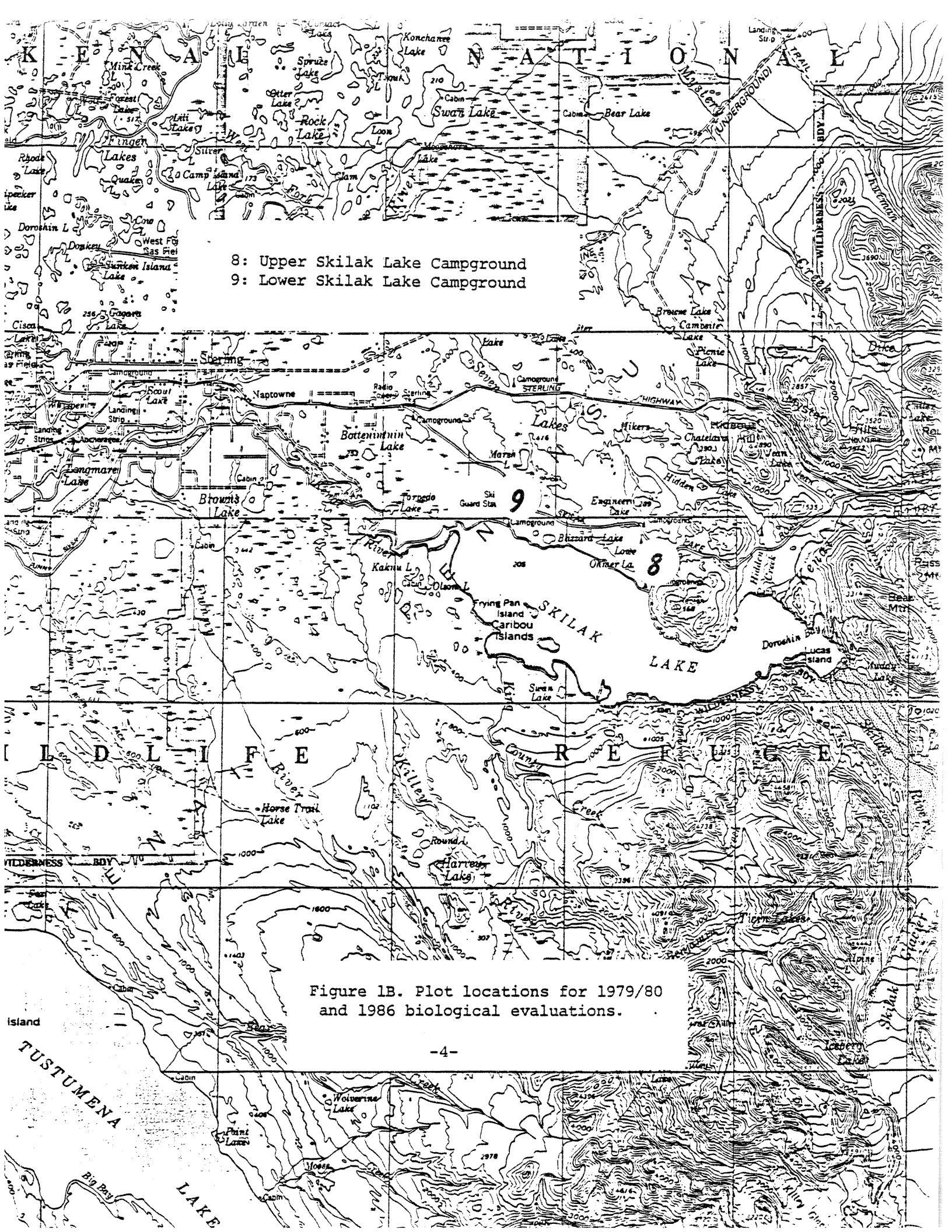

Figure 1B. Plot locations for 1979/80 and 1986 biological evaluations.

Table 1A. Beetle Populations and Related Impacts for Six Heavily Infested Areas.

	Initial Status of Beetle Trend	$\bar{X}$ Vol. (b.f./ac.)	dbh-Beetle Killed Spruce		Beetle Killed Comm. Spruce %		New Attack Comm. Spruce %		$\bar{X}$ Radial Growth (mm/yr.)		Radial Growth Increase %
			79	86	79	86	79	86	79	86	
Silvertip	Increase	7,452	14.2	13.5	10	43	17	3	.5	.9	76
Russian River	Decrease	15,954	13.6	14.1	7	65	10	20	.6	.9	52
Lower Skilak	Decrease	4,656	9.2	9.7	4	9	1	0	.7	.9	23
Upper Skilak	Static	8,039	14.0	12.3	64	68	16	0	1.0	1.3	30
Snug Harbor	Static	6,578	12.4	12.5	35	55	38	1	0.6	1.2	100
Cooper Landing	Increase	5,069	13.5	10.6	37	74	41	0	.8	1.5	88
-------$\bar{X}$		7,958	12.8	12.1	31*	61	21	4	0.7	1.1	62

*Lower Skilak was not included as stand is predominately composed of small diameter spruce and thus, not conducive to outbreaks.

The Russian River area is located along the trail to Lower Russian Lake. This spruce stand was under light beetle attack by beetles in 1979 and the outbreak was described as decreasing (Table 1A). Only 7% of the commercial spruce had been killed and 10% of the spruce were recently attacked by bark beetles. Radial growth of dominant spruce averaged 0.6mm/year.

Lower Skilak Lake campground vegetation is mostly white spruce. Mean diameter of spruce was 8 inches; a stand not conducive to spruce beetle outbreaks due to the small diameter classes. Only 4% of the commercial stems in 1979 had been killed by bark beetles and populations were described as decreasing (Table 1A). Radial growth of the dominant spruce averaged 0.7mm/year.

The Snug Harbor stand is located on the hillside above the junction of the Sterling Highway and Snug Harbor Road. Spruce beetle populations were described as static in this predominantly Lutz spruce stand. Thirty-five percent of the commercial volume was spruce beetle killed by 1979. Radial growth of the dominants averaged 0.6mm/year (Table 1A). We concluded that beetle activity would continue for at least two years.

The Upper Skilak Lake campground was being heavily attacked by beetles in 1979 (Table 1A) with 64% of the commercial spruce killed and 16% of the spruce under attack. The predominantly white spruce stand (93%) had a mean radial growth of dominants of 0.6mm/year. The outbreak was classified as static and we thought that the outbreak would subside in a few years because most of the susceptible spruce had been killed.

The Cooper Landing area is located behind the rifle range located on Bean Creek Road. By 1979, this stand had 37% spruce beetle-caused mortality of commercial sized trees with an additional 41% under attack. The stand was predominantly spruce with an average radial growth of the dominants of 0.8mm/year (Table 1A). Knight's sequential sampling plan indicated an increasing trend in beetle populations.

Three areas near and including the Granite Creek Campground on the Chugach National Forest were evaluated in 1980 (Holsten 1981) to determine present spruce beetle activity as well as the potential for beetle population buildup. In all areas there was little spruce beetle-caused mortality of commercial spruce (10%) (Table 1B) and the immediate threat of spruce beetle buildup appeared small due to the species mix and uneven-aged spruce stands. Dominant spruce were averaging 0.8mm/year of radial growth.

Stand Composition: In most cases, the re-evaluations were conducted in the same areas as the previous ones. Ten variable plots (BAF=10) were established in each area. Plots were established at five chain intervals on lines five chains apart throughout the stand. All trees within each plot were recorded by species and diameter at breast height (dbh). The status (new attack, old attack-dead, unattacked) of each spruce was recorded.

Table 1B. Beetle Populations and Related Impacts for Three Lightly Infested Areas Which Serve as Checks.

	Initial Status of Beetle Trend	$\bar{X}$ Vol. (b.f./ac.)	dbh-Beetle Killed Spruce		Beetle Killed Comm. Spruce %		New Attack Comm. Spruce %		$\bar{X}$ Radial Growth (mm/yr.)		Radial Growth Increase %
			80	86	80	86	80	86	80	86	
Granite Creek Campground	———	1,395	14.0	14.8	18	3	4	0	.8	1.0	19
Granite Creek Campground Rd.	———	4,134	-	-	3	1	0	0	.5	.7	40
Granite Creek Guard Station	———	5,864	12.8	12.9	10	8	0	0	1.2	1.3	8
-------$\bar{X}$		3,798	13.4	13.9	10.3	4	1.3	0	.8	1.0	22

Growth Rate: Radial growth of dominants and co-dominants was determined in all areas during the original evaluation. However, the majority of these cored trees were killed between evaluations. Accordingly, two live dominants or co-dominants per plot were cored during the 1986 re-evaluation. Average radial growth per plot (mm/yr.) was calculated for previous five years increments in order to determine if the spruce increased their growth rate due to release from the beetle-killed overstory. As changes in climatic conditions could affect growth rates, the Granite Creek areas, with their low levels of beetle activity, served as checks. Thus, any significant increase in growth rates of the live residuals in the heavily spruce beetle impacted areas could be attributed to release from competition.

RE-EVALUATIONS

Table 1A,B compares the results of the two evaluations of the nine areas. Generally speaking, the results of the 1986 re-evaluation indicate:

(1) Silvertip: Beetle activity is decreasing in this area. The infestation was originally classified as increasing. The percentage of commercial spruce killed by bark beetles rose from 10% in 1979 to 43% in 1986. Growth of unattacked residuals increased by 76% (Table 1A, Fig. 2A). Some limited beetle caused mortality will continue but will be minor.

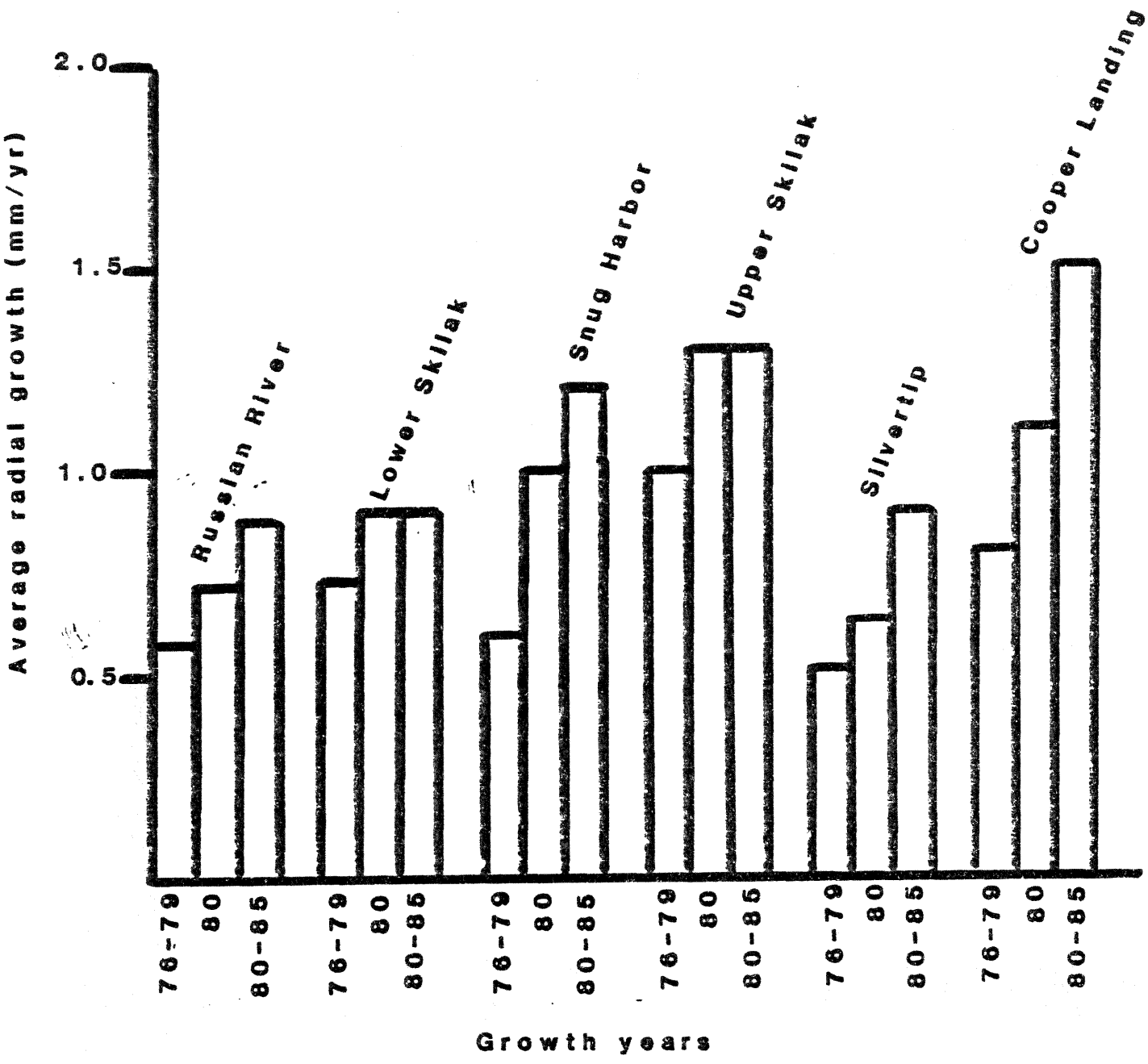

Fig. 2A. Average radial growth of heavily beetle impacted areas.

(2) Russian River: This infestation was described as decreasing in 1979 based on Knight's Sequential Sampling Plan. However, mortality of commercial spruce rose significantly from 7 to 65%. An additional 20% of the commercial spruce have been recently attacked. Beetle activity is anticipated to remain high in this area for two years. Unattacked live residuals have increased their radial growth by 52% (Table IA). The discrepancy between the original population forecast and what resulted was in part due to: (a) small area evaluated in 1976 (b) poor location of transects, and (c) rapid build-up of beetles in areas close to the study site which provided a large source of attacking adults. They caused increased spruce mortality in the study area.

(3) Lower Skilak: Beetle populations in this area were described as decreasing in 1979. Percent of commercial spruce killed by beetles rose from 4% to 9% in six years, but 85% of the commercial spruce remain free of attack. This stand is composed predominantly of small diameter spruce which are not conducive to bark beetle outbreaks. Beetle activity in this area resulted from a spill-over of beetles from surrounding stands which were heavily attacked by spruce beetles. The Lower Skilak stand has increased its radial growth by 23%. However, this increase is similar to the growth rate obtained by the Granite Creek check areas (22%) (Table 1B, Fig.2B). Consequently, this increase is probably not due to release from competition because little of the Lower Skilak overstory was beetle killed.

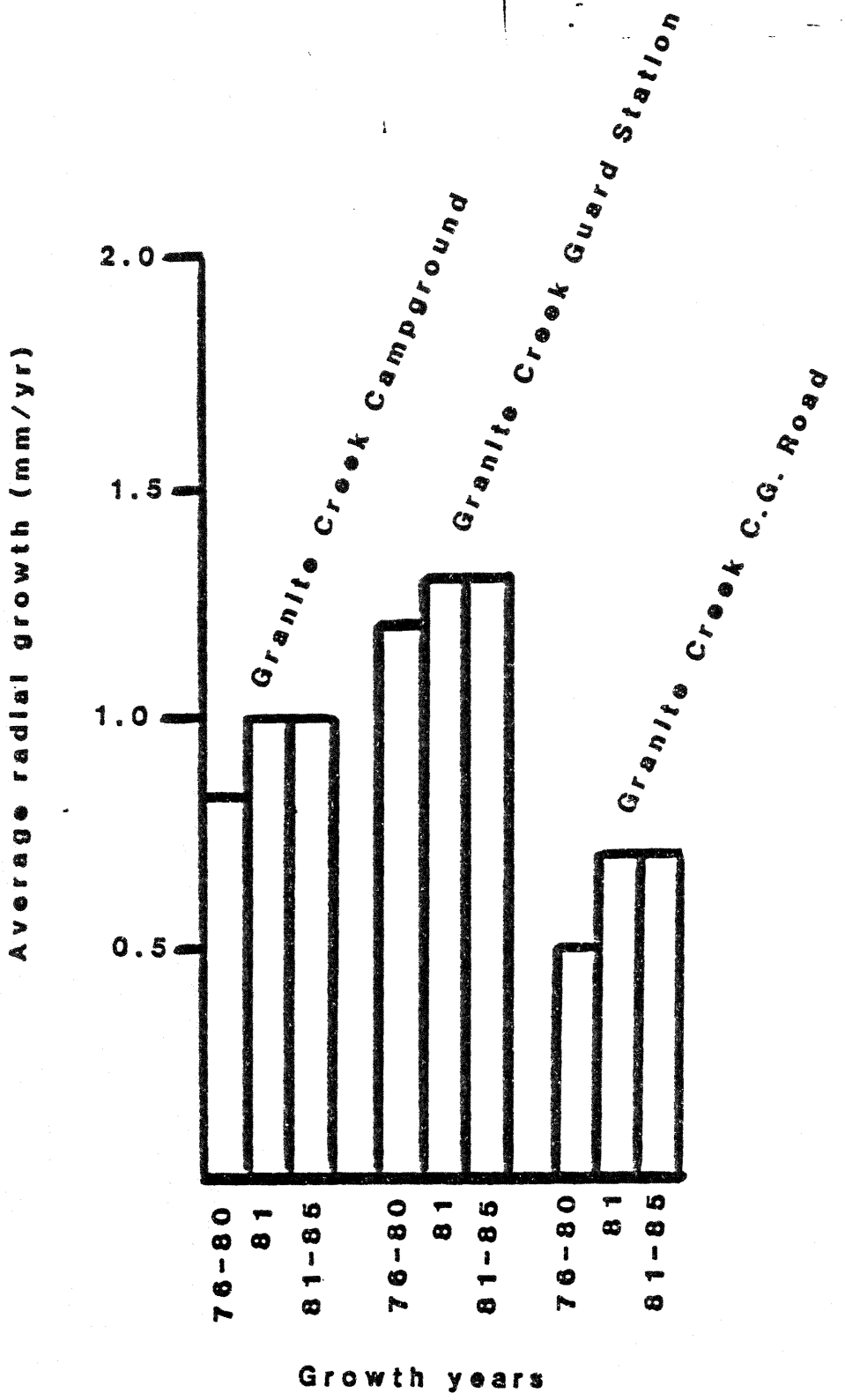

Fig. 2B. Average radial growth by year of lightly beetle impacted areas-checks.

(4) Upper Skilak: These stands sustained 64% mortality by 1979. Beetle populations were classified as static but appear to have decreased because only an additional 4% mortality of the commercial spruce occurred in the following six years. The live unattacked dominants and co-dominants have increased their radial growth by 30%, which differs little from the growth rate shown in the Granite Creek areas.

(5) Snug Harbor: Beetle populations were classified as static in 1979, but with additional mortality expected. Percent mortality is now 55%, a 20% increase over 1979 levels. This outbreak is over as shown by the low level (1%) of new attacks recorded in 1986 (Table 1A). Thirty-one percent of the commercial spruce remains uninfested and has responded well to release with a 100% increase in radial growth.

(6) Cooper Landing: This stand sustained 37% mortality of commercial spruce by 1979 and beetle populations were forecasted as increasing. This forecast was accurate because mortality is now 74%. The infestation has subsided in the area and no new attacks were recorded in 1986. The uninfested residuals have responded well to release with an 88% increase in radial growth.

(7) The three Granite Creek areas were originally evaluated because they were important for recreational values. Beetle activity was and is still low (Table 1B, Fig.2B). By 1986, 96% of the commercial timber were still unattacked and the average growth rate of these stands increased only 22% versus an average of 62% for the beetle impacted areas.

SUMMARY

Growth rates increased more rapidly in the heavily beetle impacted areas than in the check areas. The average adjusted growth increase in the beetle impacted areas is 40% when the percent increase of the check areas is considered. Even though the live residual stands are responding well to release, their average growth rate is still low (1.1 mm/year). As these stands mature and diameters increase, growth rate can be expected to decrease. These stands will again become susceptible to spruce bark beetle outbreaks unless they receive silvicultural treatments (Hard and Holsten 1985).

Based on the average "life" of an outbreak in five of the six impacted areas described above (Lower Skilak excluded due relatively small diameters of spruce and consequently low beetle activity), we can expect an average of 61% mortality of the commercial spruce. In areas of endemic beetle activity such as the Granite Creek area, less than 1% of the commercial spruce will probably be killed annually by bark beetles within the next few years. However, present average annual radial growth in these areas is low (1.0 mm/year). If these stands are allowed to continue to stagnate, we can expect increased beetle activity, if not outbreak conditions.

The re-evaluations have shown that our accuracy at forecasts is fair at best. Care must be taken to sample infested areas adequately and to modify forecasts based on spruce beetle activity in surrounding stands. Extrapolations from a small sampled area to describe a larger affected area should be viewed cautiously.

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APPENDIX

Spruce beetle

Dendroctonus rufipennis (Kirby)
(Coleptera:Scolytidae)

HOSTS: Engelmann, white, Lutz, Sitka, and rarely black spruce

DISTRIBUTION: Wherever spruce is found; a serious forest pest in south-central Alaska throughout Cook Inlet and Kenai Peninsula.

DAMAGE: Larvae feed beneath bark, usually killing affected trees.

DESCRIPTION: Adult spruce beetles are dark maroon to black, cylindrical in shape, aproximately 5 mm long and 3 mm wide. Larvae are stout, white, legless grubs, 6 mm long when full-grown. The pupae are soft-bodied, white, and have some adult features.

BIOLOGY: The life cycle of the spruce beetle may vary from one to three years, with a two-year cycle being the most common. Temperature plays an important part in determining the length of time required for beetle development.

Adult beetles become active in the spring (late May -- early June) when air temperatures reach a threshold of 14.5 C. At this time, beetles emerge from trees in which they overwintered and fly in search of new host material. These dispersal flights may be short-range even though beetles are capable of flying for several miles without stopping.

Spruce beetles prefer to attack the sides and bottom surfaces of windthrows or other down material which have been on the ground less than one year. In the absence of such host material, large-diameter live trees may be attacked instead, and if beetle populations are high, these trees may be killed.

Beetle attacks, whether on windthrows or in standing timber, are mediated by pheromones which insure that individual trees will be attacked "en masse", and fully colonized by subsequent broods. Trees that are mass-attacked form attractive centers which result in groups of trees being killed by spillover attacks.

Female beetles initiate attacks and begin constructing an egg gallery in the cambium parallel to the grain of the tree. They are joined by males and after mating, lay eggs in small niches along the sides of the egg gallery. Most eggs will hatch by August.

As they feed in the cambium, larvae construct their own galleries perpendicular to the egg gallery. Normally, spruce beetles will pass the first winter in the larval stage, resume feeding the next spring, and pupate by summer. About two weeks later, pupae transform into adults which will pass the second winter, either in the old pupation site, or more commonly, in the bases of infested trees. The following spring, two years after the initial attack, the new temperatures are high, or on certain warmer microsites, spruce beetles may complete their development within one season and new adults will emerge one year after attack.

Virtually all major outbreaks of spruce beetle have originated from stand disturbances -- blowdown, logging, or right-of-way clearance (Wygant and LeJeune 1967). Stand susceptibility to beetle attack is influenced by stocking, with slow growth and moisture stress playing an important part in predisposing trees to attack.